Effects of Crop Management System on Arbuscular Mycorrhizal Fungi (AMF) Diversity, and its Influence on Soybean Tolerance to Water Stress

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This study aims to compare the effect of two inocula of Arbuscular Mycorrhizal Fungi (AMF) from two production management systems, in the physiological response of soybean plants to water deficit. This experiment was conducted under greenhouse conditions, in which soybean plants were inoculated with different AMF inoculum; one from a conventional farming system (CVF) and the other one from a soil building (organic farming) system (OGF). Plants were subjected to a moderate water deficit.

The experiment was performed in the greenhouses of the Department of Horticulture and Landscape Architecture at Purdue University. Soil samples from a lot with conventional management (CVF) and from a soil with soil building practices (OGF) were collected. AMF spores of rhizosphere samples were extracted by the wet sieving method and gradient of sucrose (20% and 70%). An abundance of 35.84 and 75.83 spores/visual field were found for the CVF and OGF soils, respectively (Table 1). Based on the count of spores extracted, the Shannon diversity index and Jaccard index were calculated. Spores were classified by size, shape and color, and we found 5 shared morphospecies by organic and conventional systems. However, a total of 31 morphospecies were counted in the conventional system and 42 morphospecies in the soil building system. The AMF colonization rate was determined with the intersection magnified method (McGonigle et al., 1990) using a 40X objective microscope lens.

Table 1. AMF abundance and diversity in conventional and soil building systems.

Crop system	Abundance* (number of spores in 50 g)	Shannon Index (H')*	Jaccard similarity index
Conventional	35.84	2.50	0.11
Soil Building	75.83	2.79	

*Average of 3 integrated samples of three replicates taken for each cultivation system.

Rhizosphere samples of soybean plants collected in conventional and soil building systems were sieved using a 2 mm soil sieve, then the roots were cut into pieces and mixed with the sieved soil again. Finally, the inoculum was dried at room temperature (21° C) for two weeks. The control treatment was prepared with microbial washing with a mixture of 150 ml of the CVF inoculum and 150 ml of the OGF inoculum to obtain a filtrate free of spores or AMF structures. Soybeans seeds were surface sterilized and inoculated with 1.4 g Bradyrhizobia japonicum. Plants were fertilized weekly with a modified Hoagland nutrient solution (Taffouo et al., 2014). Soil moisture was measured with a Decagon EC-5 sensor, and stomatal conductance was measured weekly in the third fully extended leaf with a leaf porometer. The experiment was

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established as a split plot design. Each replicate had three pots under drought conditions and another three pots in well-watered conditions (field capacity).

The results obtained indicate that soil building practices generated more abundant and diverse AMF communities that provided soybean plants a better response in water deficit conditions. This was reflected in an increase in production, through increased stomatal conductance (Control=420.27, CVF=543.09, and OGF=516.28 mmol m^{-2} s^{-1}), biomass gain (Control=9.64 g, CVF=12.06 g, and OGF=17.43 g), and increased dry weight of the pods (Control=5.95 g, CVF=9.05 g, and OGF=12.53 g) under water deficit (Table 2). In conclusion the presence of AMF inoculum from soil building systems was beneficial for soybeans to tolerate water deficits, allowing for better plant status and increased production under these conditions.

Table 2. AMF inoculum effects on soybean plant growth under irrigated (no stress) and water stress conditions.

Treatment		Stomatal conductance gs	Shoot dry weight	Pod yield (g plant^{-1})
No Stress	Control (CNT)	0.403 b	7.09 b	4.26 b
	Conventional (CVF)	0.591 a	12.47 b	9.53 a
	Soil Building (OGF)	0.553 b	10.14 b	8.21 a
With Stress	Control (CNT)	0.420 b	7.97 b	5.95 b
	Conventional (CVF)	0.597 a	11.33 b	9.05 b
	Soil Building (OGF)	0.611 a	15.24 a	12.53 a

*The data represent averages (n=3); in the columns, means in same stress group followed by the same letter were not significantly different ($p > 0.05$) by the Tukey test.

References

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